Total dose testing of the HS9-508BEH 8-channel analog multiplexer

Nick van Vonno
Intersil Corporation

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1. Introduction

This report provides results of low and high dose rate total dose testing of the HS9-508BEH 8-channel analog multiplexer. The test was conducted in order to determine the sensitivity of the part to the total dose environment and to identify any low dose rate sensitivity.

The HS-508BEH is produced in two versions. The HS-508BRH is acceptance tested on a wafer by wafer basis at high dose rate only. The HS-508BEH is acceptance tested at both low and high dose rate on a wafer by wafer basis. The parts are otherwise identical, including the die.

2. Reference Documents

MIL-STD-883 test method 1019
HS9-508BEH data sheet, Intersil document FN4824
DSCC Standard Microcircuit Drawing (SMD) 5962-96742

3: Part Description

The HS-508BEH is a dielectrically isolated, radiation hardened, 8-channel CMOS analog multiplexer able to withstand analog input voltages well in excess of the supplies. This is essential in any system where the analog inputs originate outside the equipment. The HS-508BEH can withstand a continuous input up to 10V greater than either supply, which eliminates the possibility of damage when supplies are off, but input signals are present. Equally important, the HS-508BEH can withstand brief input transient spikes of several hundred volts, which would otherwise require complex external protection networks. Necessarily, ON resistance is somewhat higher than similar unprotected devices, but very low switch leakage current combines to produce low errors. Reference Application Notes 520 and 521 for further information on the HS-508BRH, HS-508BEH multiplexers. The HS-508BRH and HS-508BEH have been specifically designed to meet exposure to radiation environments. Operation from -55°C to +125°C is guaranteed.

The HS9-508BEH is built in the RSG dielectrically isolated silicon gate BiCMOS process, which not only avoids latchup from electrical or single-event causes but also enables high performance in cold spared applications, as discussed above. A block diagram and other functional details can be found in the SMD.

4: Test Description

4.1 Irradiation Facilities

Low dose rate testing was performed using the Intersil ^{60}Co low dose rate irradiator located in the Palm Bay, Florida Intersil facility. The low dose rate work was performed at .010rad(Si)/s per MIL-STD-883 Method 1019. A PbAl spectrum hardening box was used to shield the test fixture and devices under test against low energy secondary gamma radiation.

High dose rate testing was performed using the Intersil Gammacell 220 high dose rate irradiator located in the Palm Bay, Florida Intersil facility. The high dose rate work was performed at 60rad(Si)/s per MIL-STD-883 Method 1019 as part of the Intersil wafer by wafer RLAT procedure.

4.2 Test Fixturing

The configuration used for biased irradiation was in conformance with Standard Microcircuit Drawing (SMD) 5962-96742.

4.3 Characterization equipment and procedures

All electrical testing was performed outside the irradiator using the production automated test equipment (ATE) with datalogging at each downpoint. Downpoint electrical testing was performed at room temperature. The high dose rate data was derived from RLAT results.

4.4 Experimental matrix

The experimental matrix for the low dose rate work consisted of twelve samples irradiated at low dose rate with all pins grounded and twelve samples irradiated at low dose rate under bias. One control unit was used.

The high dose rate data was derived from RLAT data. These acceptance tests are performed under bias with no intermediate downpoints to a maximum total dose of 100krad(Si). The sample size was 76, representing 19 wafers.

All samples of the HS9-508BEH were drawn from production lot DTM8CEH and were packaged in the standard hermetic 16-lead (code CDFP4-F16) solder-sealed production flatpack. Samples were processed through the standard burnin cycle before irradiation, as required by MIL-STD-883, and were screened the SMD 5962-96742 limits at room, low and high temperatures.

4.5 Downpoints

Downpoints for the low dose rate tests were zero, 50krad(Si), 100krad(Si) and 150krad(Si), while downpoints for the high dose rate tests were zero and 100krad(Si).

5: Results

5.1 Test results

Testing at both dose rates to 150krad(Si) of the HS9-508BEH is complete and showed no reject devices after irradiation, screening to both the SMD pre- and post-irradiation limits.

5.2 Variables data

The plots in Figures 1 through 17 show selected parameter data at all downpoints. The plots show the median of key parameters as a function of total dose for each of the two irradiation conditions. All parts showed excellent stability over irradiation.

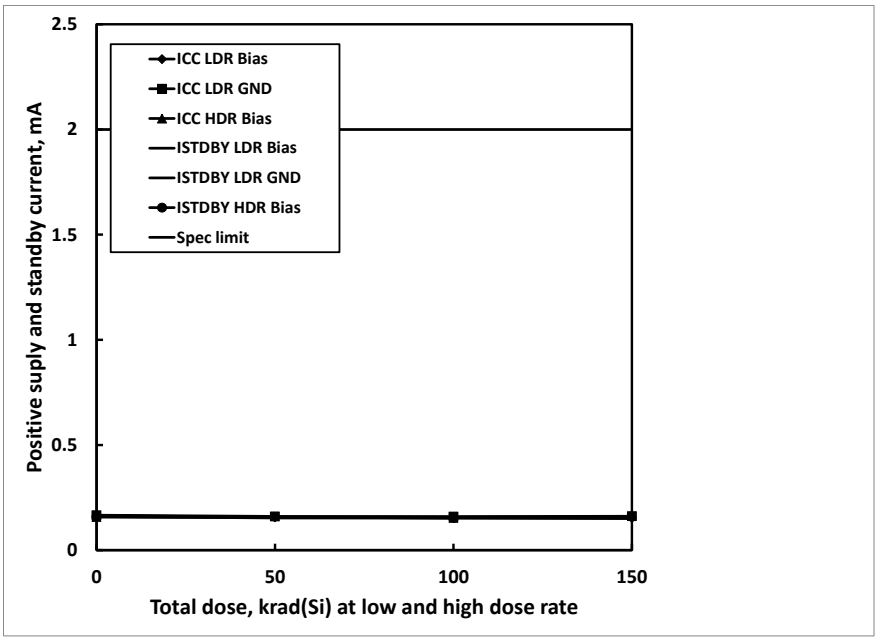

Figure 1: HS9-508BEH positive supply current and standby current as a function of total dose irradiation at low dose rate (biased and unbiased) and at high dose rate (biased only). The low dose rate was 0.01rad(Si)/s and the high dose rate was 60rad(Si)/s. Sample size for each low dose rate cell was 12, while the high dose rate sample size was 76. The SMD pre-irradiation limit is 2.0mA maximum. All four curves are coincident.

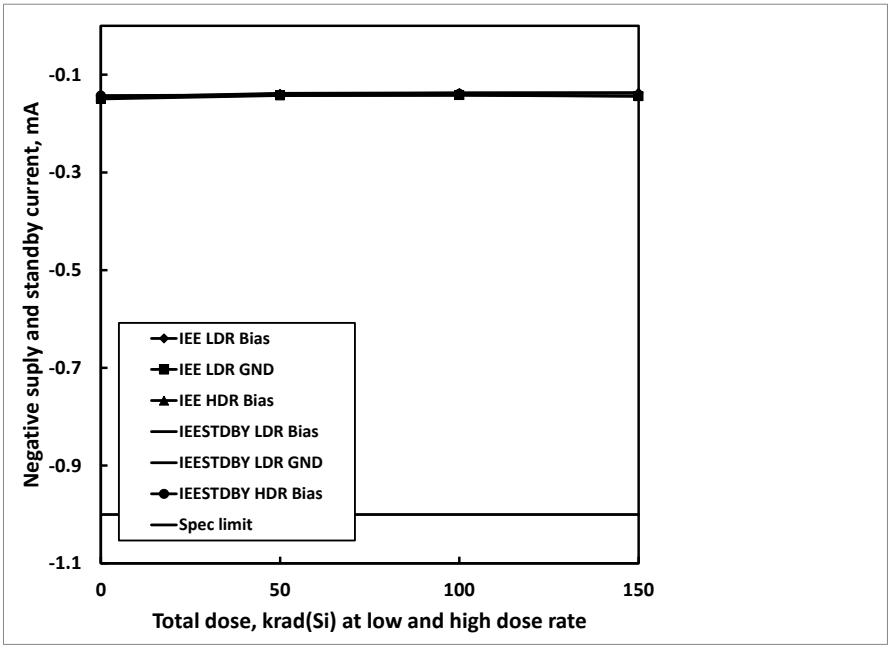

Figure 2: HS9-508BEH negative supply current and standby current as a function of total dose irradiation at low dose rate (biased and unbiased) and at high dose rate (biased only). The low dose rate was 0.01rad(Si)/s and the high dose rate was 60rad(Si)/s. Sample size for each low dose rate cell was 12, while the high dose rate sample size was 76. The SMD pre-irradiation limit is -1.0mA maximum. All four curves are coincident.

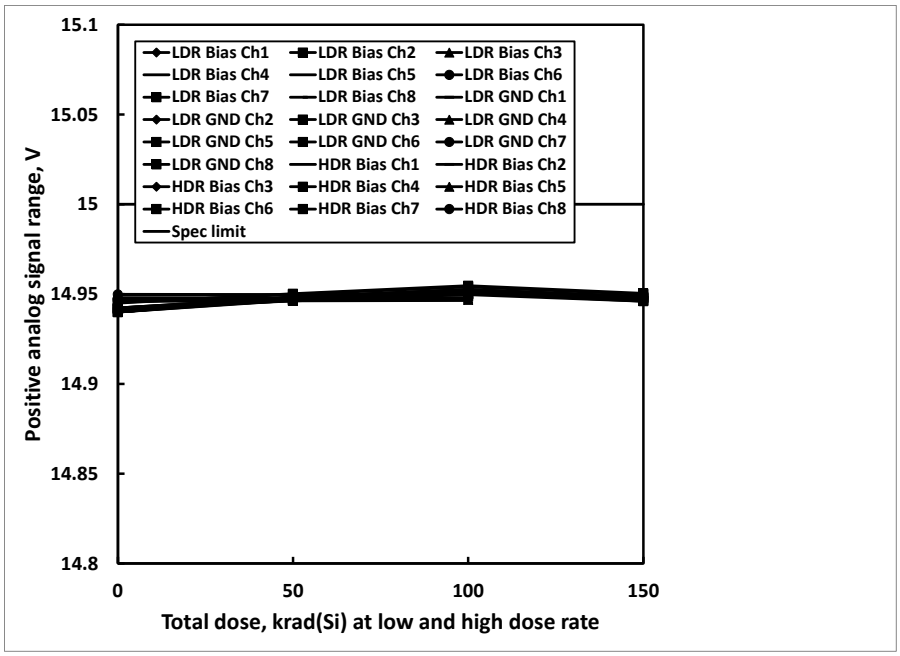

Figure 3: HS9-508BEH positive analog signal range as a function of total dose irradiation at low dose rate (biased and unbiased) and at high dose rate (biased only). The low dose rate was 0.01rad(Si)/s and the high dose rate was 60rad(Si)/s. Sample size for each low dose rate cell was 12, while the high dose rate sample size was 76. The SMD pre-irradiation limit is 15.0V maximum. All sixteen curves are nearly coincident.

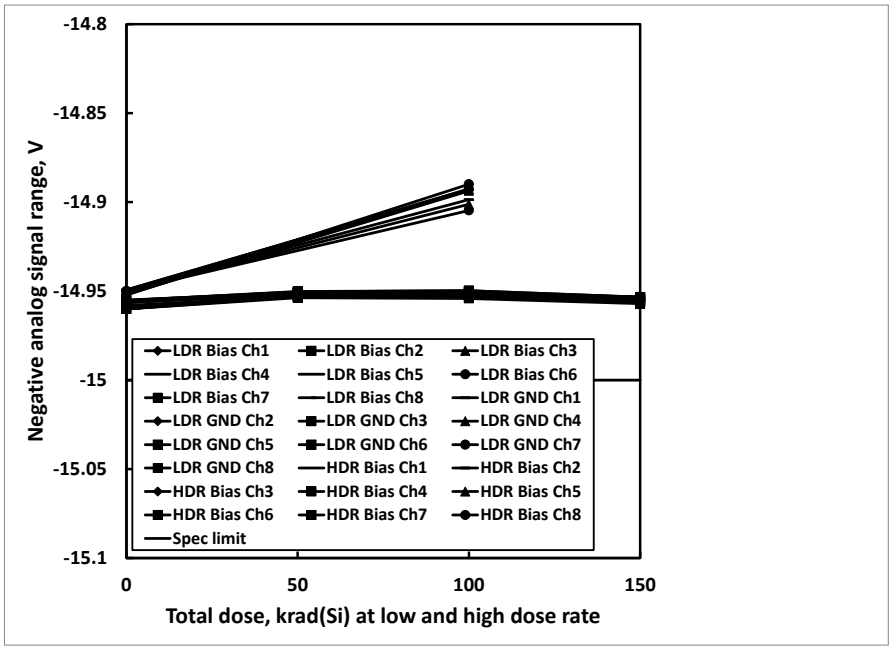

Figure 4: HS9-508BEH negative analog signal range as a function of total dose irradiation at low dose rate (biased and unbiased) and at high dose rate (biased only). The low dose rate was 0.01rad(Si)/s and the high dose rate was 60rad(Si)/s. Sample size for each low dose rate cell was 12, while the high dose rate sample size was 76. The SMD pre-irradiation limit is -15.0V maximum. All sixteen curves are nearly coincident.

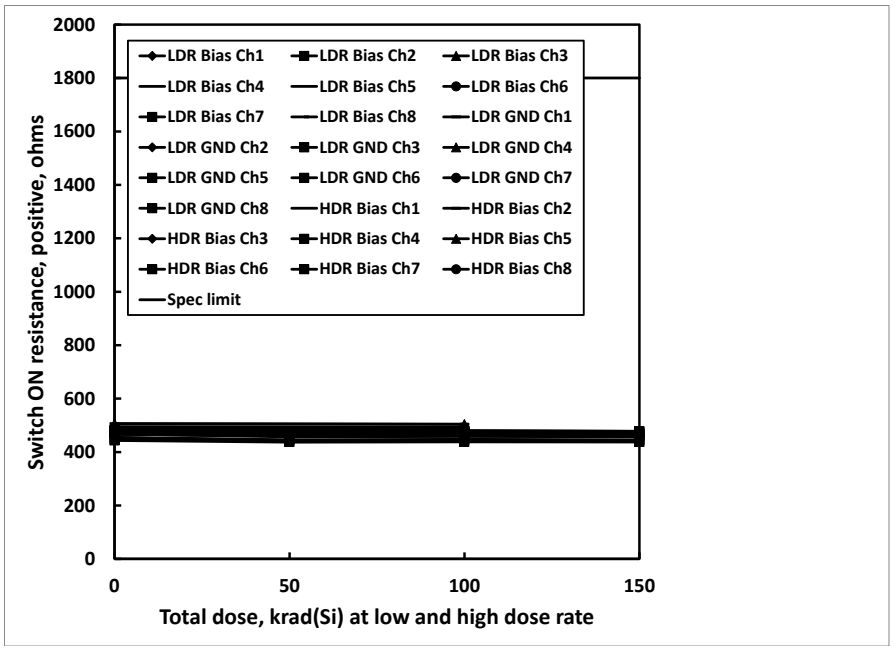

Figure 5: HS9-508BEH positive ON resistance as a function of total dose irradiation at low dose rate (biased and unbiased) and at high dose rate (biased only). The low dose rate was 0.01rad(Si)/s and the high dose rate was 60rad(Si)/s. Sample size for each low dose rate cell was 12, while the high dose rate sample size was 76. The SMD pre-irradiation limit is 1800 ohms maximum. All sixteen curves are nearly coincident.

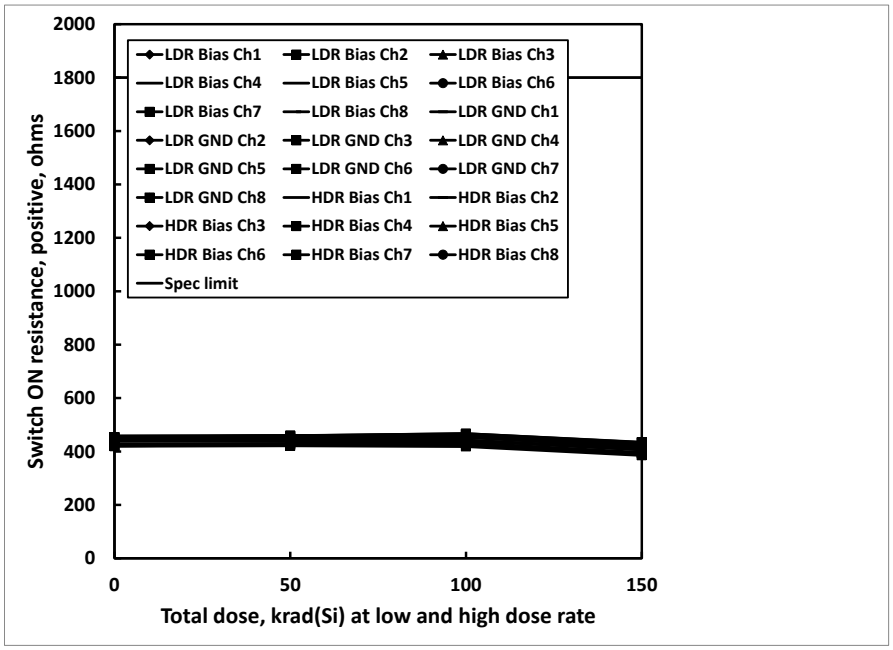

Figure 6: HS9-508BEH negative ON resistance as a function of total dose irradiation at low dose rate (biased and unbiased) and at high dose rate (biased only). The low dose rate was 0.01rad(Si)/s and the high dose rate was 60rad(Si)/s. Sample size for each low dose rate cell was 12, while the high dose rate sample size was 76. The SMD pre-irradiation limit is 1800 ohms maximum. All sixteen curves are nearly coincident.

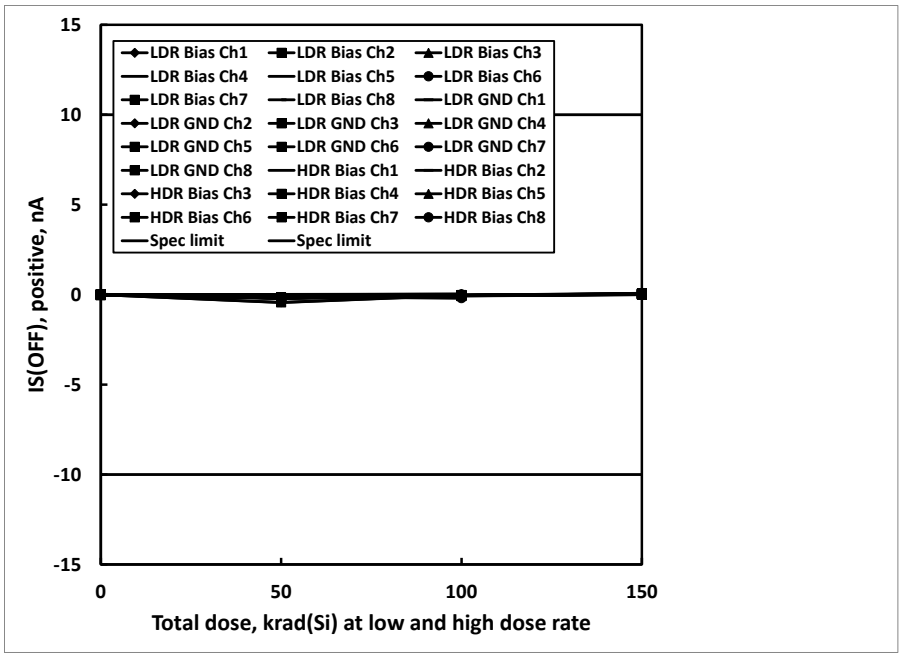

Figure 7: HS9-508BEH positive OFF source leakage as a function of total dose irradiation at low dose rate (biased and unbiased) and at high dose rate (biased only). The low dose rate was 0.01rad(Si)/s and the high dose rate was 60rad(Si)/s. Sample size for each low dose rate cell was 12, while the high dose rate sample size was 76. The SMD pre-irradiation limits are -10.0nA to +10.0nA. All sixteen curves are nearly coincident.

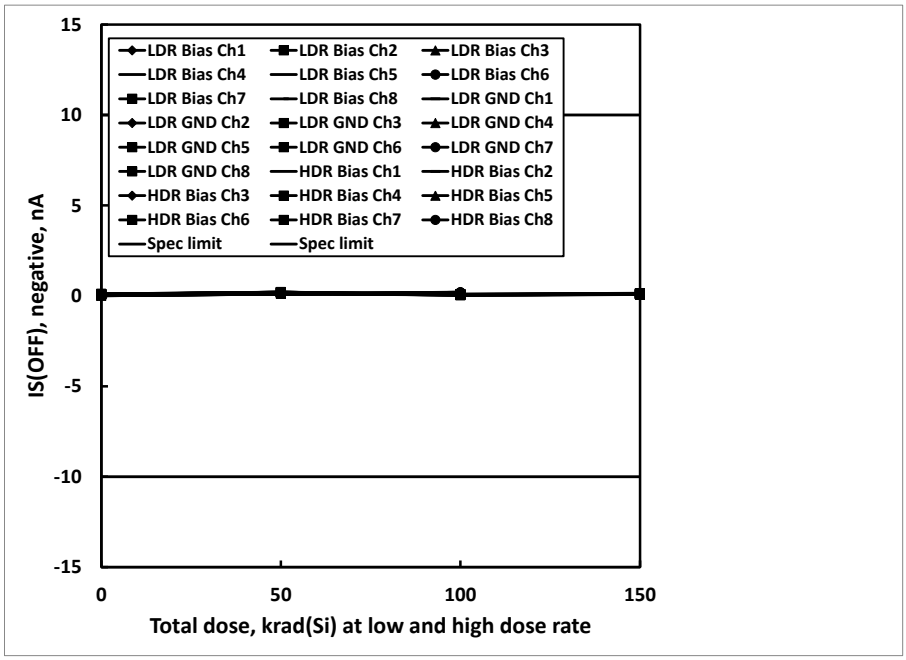

Figure 8: HS9-508BEH negative OFF source leakage as a function of total dose irradiation at low dose rate (biased and unbiased) and at high dose rate (biased only). The low dose rate was 0.01rad(Si)/s and the high dose rate was 60rad(Si)/s. Sample size for each low dose rate cell was 12, while the high dose rate sample size was 76. The SMD pre-irradiation limits are -10.0nA to +10.0nA. All sixteen curves are nearly coincident.

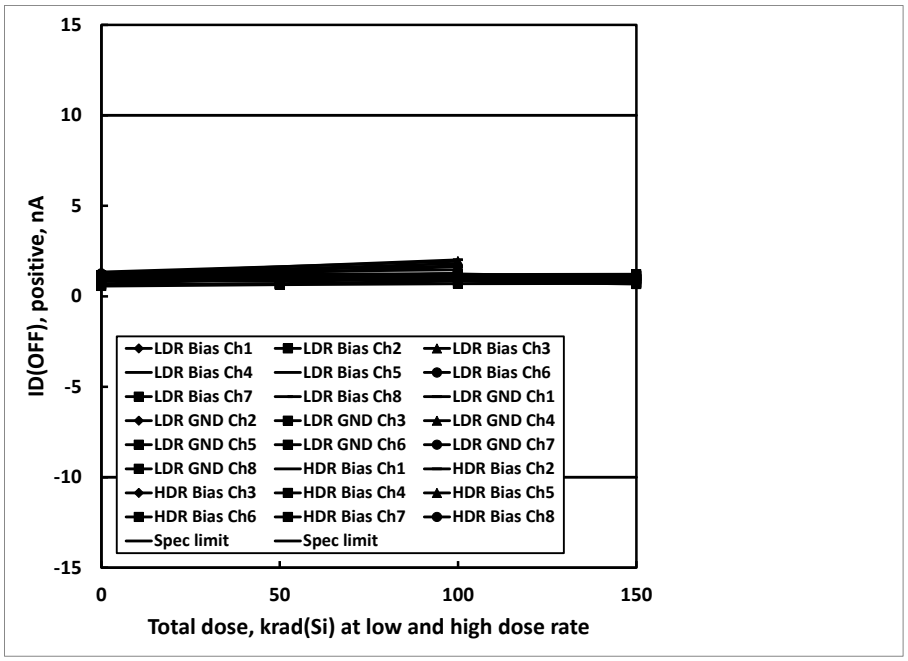

Figure 9: HS9-508BEH positive OFF drain leakage as a function of total dose irradiation at low dose rate (biased and unbiased) and at high dose rate (biased only). The low dose rate was 0.01rad(Si)/s and the high dose rate was 60rad(Si)/s. Sample size for each low dose rate cell was 12, while the high dose rate sample size was 76. The SMD pre-irradiation limits are -10.0nA to +10.0nA. All sixteen curves are nearly coincident.

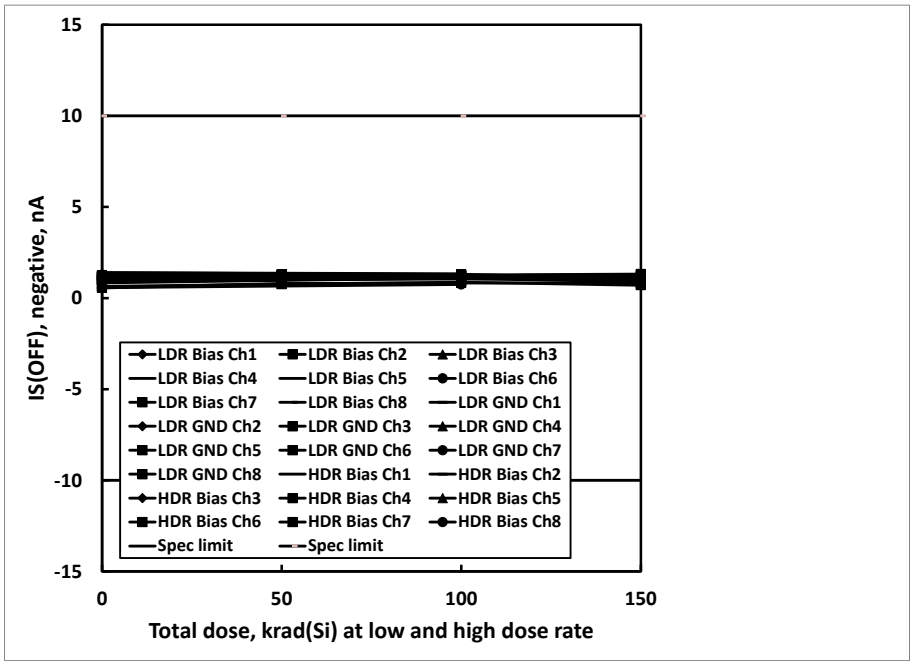

Figure 10: HS9-508BEH negative OFF drain leakage as a function of total dose irradiation at low dose rate (biased and unbiased) and at high dose rate (biased only). The low dose rate was 0.01rad(Si)/s and the high dose rate was 60rad(Si)/s. Sample size for each low dose rate cell was 12, while the high dose rate sample size was 76. The SMD pre-irradiation limits are -10.0nA to +10.0nA. All sixteen curves are nearly coincident.

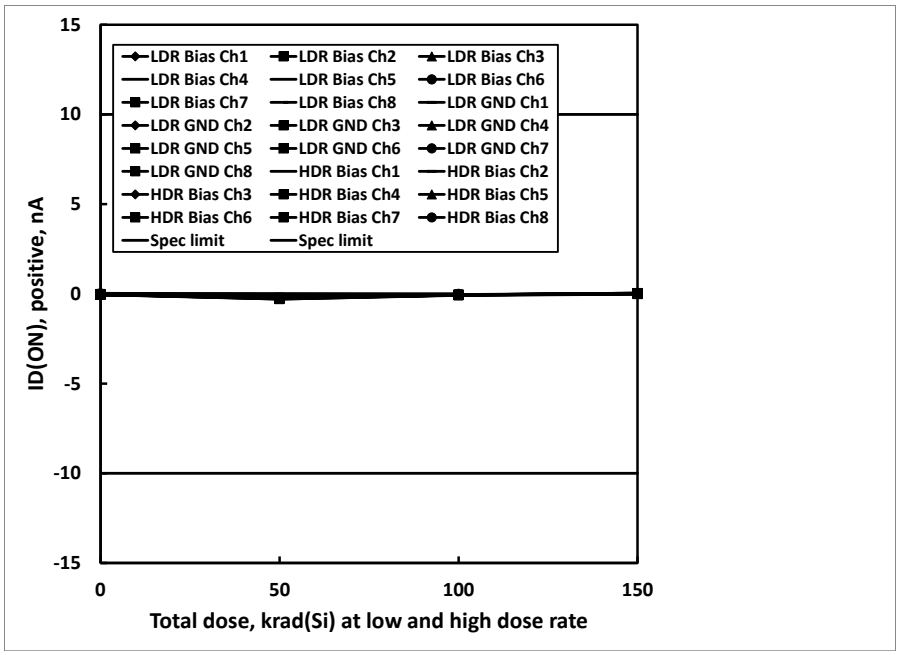

Figure 11: HS9-508BEH positive ON drain leakage as a function of total dose irradiation at low dose rate (biased and unbiased) and at high dose rate (biased only). The low dose rate was 0.01rad(Si)/s and the high dose rate was 60rad(Si)/s. Sample size for each low dose rate cell was 12, while the high dose rate sample size was 76. The SMD pre-irradiation limits are -10.0nA to +10.0nA. All sixteen curves are nearly coincident.

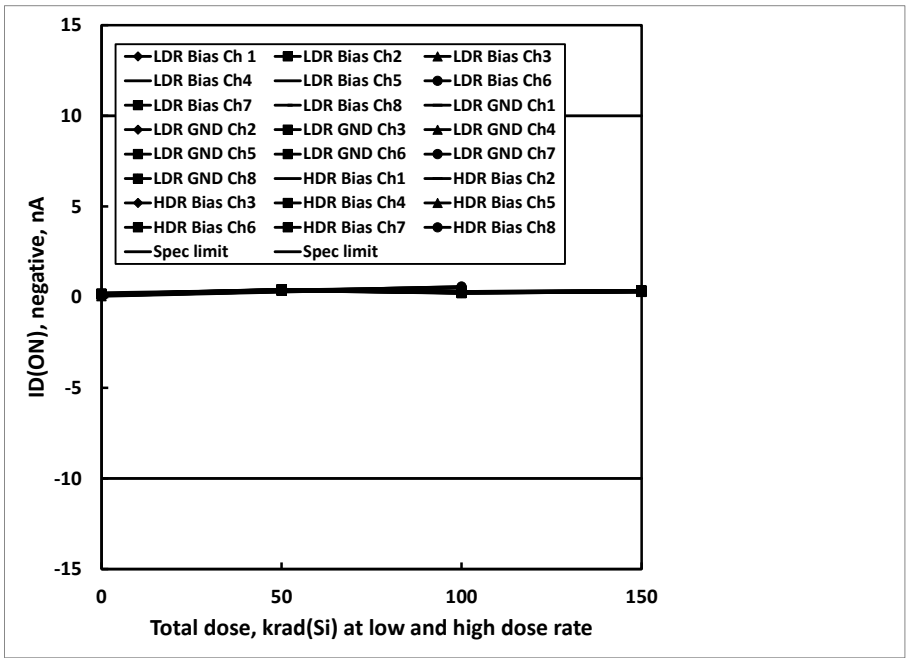

Figure 12: HS9-508BEH negative ON drain leakage as a function of total dose irradiation at low dose rate (biased and unbiased) and at high dose rate (biased only). The low dose rate was 0.01rad(Si)/s and the high dose rate was 60rad(Si)/s. Sample size for each low dose rate cell was 12, while the high dose rate sample size was 76. The SMD pre-irradiation limits are -10.0nA to +10.0nA. All sixteen curves are nearly coincident.

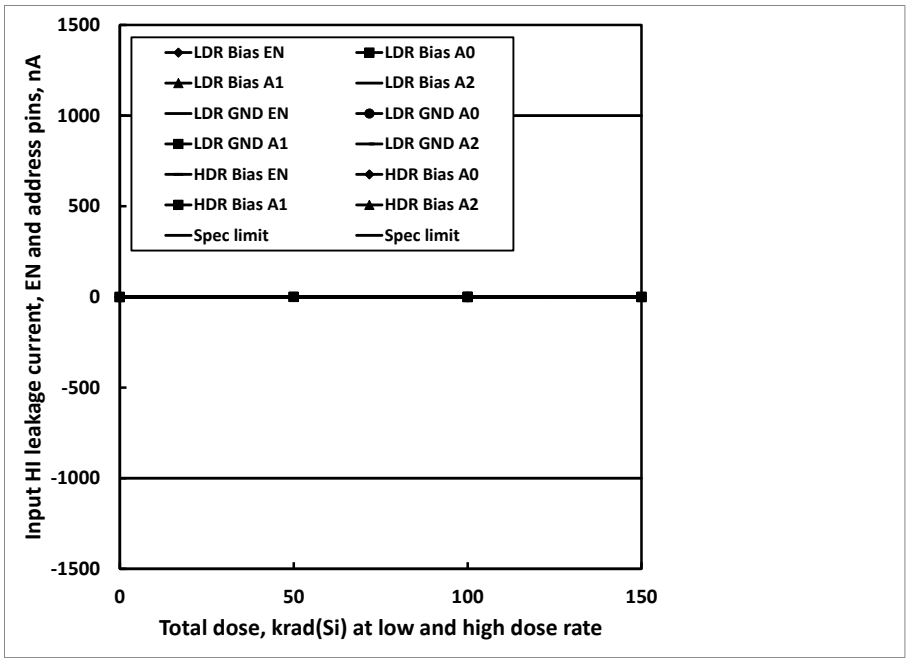

Figure 13: HS9-508BEH input HIGH leakage current, enable and address pins, as a function of total dose irradiation at low dose rate (biased and unbiased) and at high dose rate (biased only). The low dose rate was 0.01rad(Si)/s and the high dose rate was 60rad(Si)/s. Sample size for each low dose rate cell was 12, while the high dose rate sample size was 76. The SMD pre-irradiation limits are -1000.0nA to +1000.0nA. All eight curves are nearly coincident.

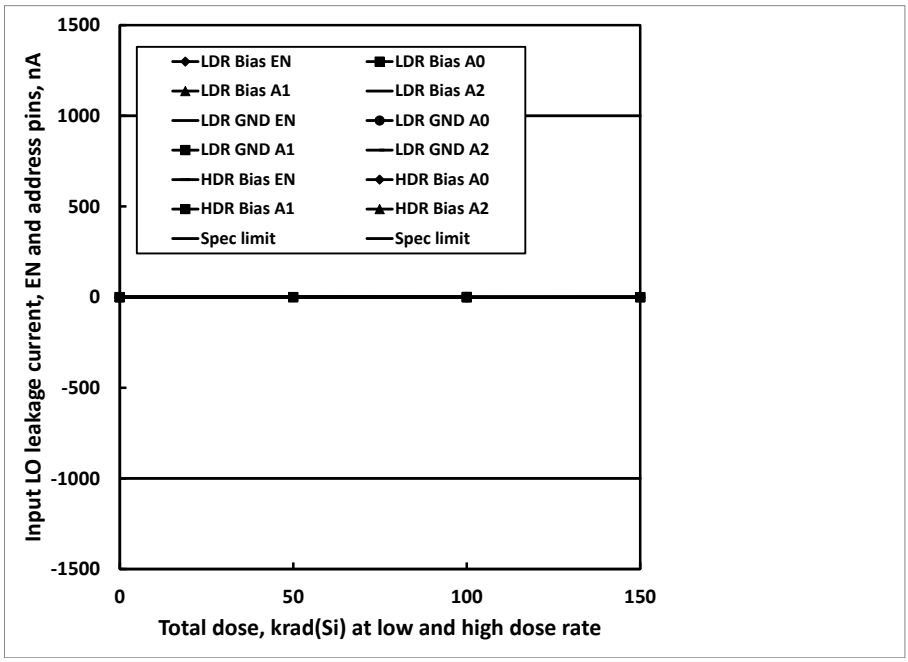

Figure 14: HS9-508BEH input LOW leakage current, enable and address pins, as a function of total dose irradiation at low dose rate (biased and unbiased) and at high dose rate (biased only). The low dose rate was 0.01rad(Si)/s and the high dose rate was 60rad(Si)/s. Sample size for each low dose rate cell was 12, while the high dose rate sample size was 76. The SMD pre-irradiation limits are -1000.0nA to +1000.0nA. All eight curves are nearly coincident.

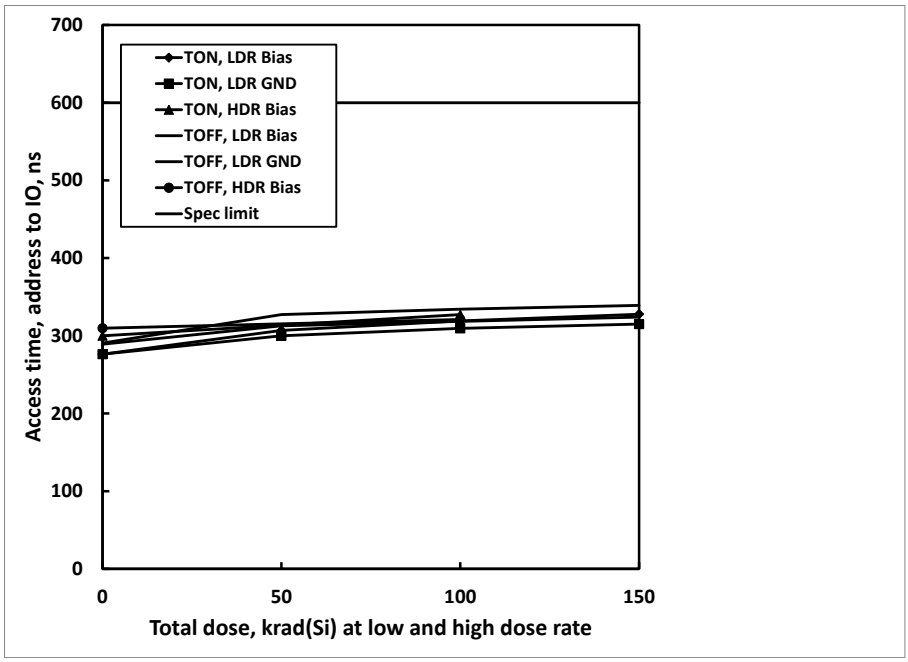

Figure 15: HS9-508BEH address to switch access time as a function of total dose irradiation at low dose rate (biased and unbiased) and at high dose rate (biased only). The low dose rate was 0.01rad(Si)/s and the high dose rate was 60rad(Si)/s. Sample size for each low dose rate cell was 12, while the high dose rate sample size was 76. The SMD pre-irradiation limit is 600ns maximum.

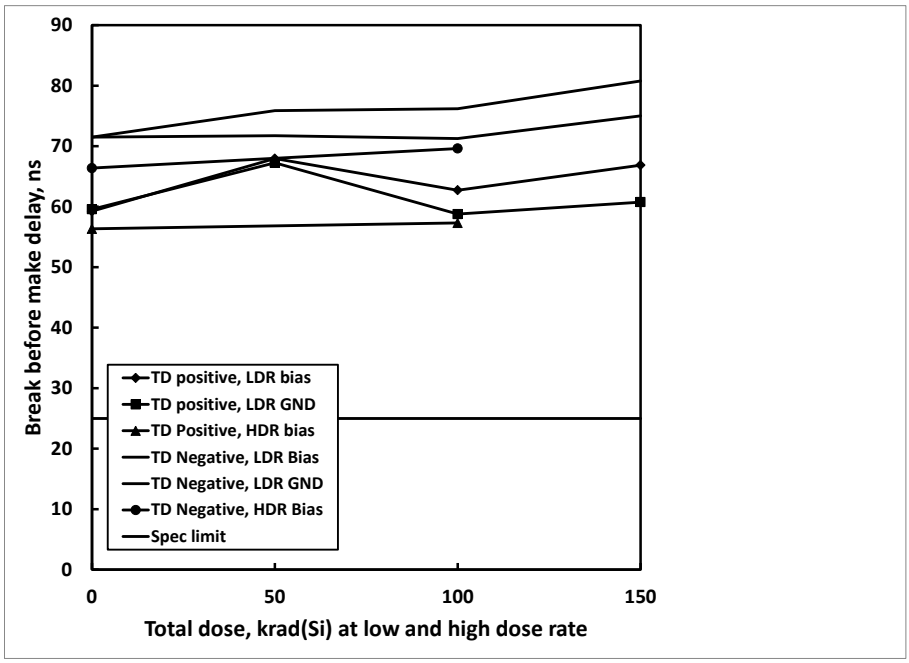

Figure 16: HS9-508BEH break before make delay as a function of total dose irradiation at low dose rate (biased and unbiased) and at high dose rate (biased only). The low dose rate was 0.01rad(Si)/s and the high dose rate was 60rad(Si)/s. Sample size for each low dose rate cell was 12, while the high dose rate sample size was 76. The SMD pre-irradiation limit is 25ns minimum.

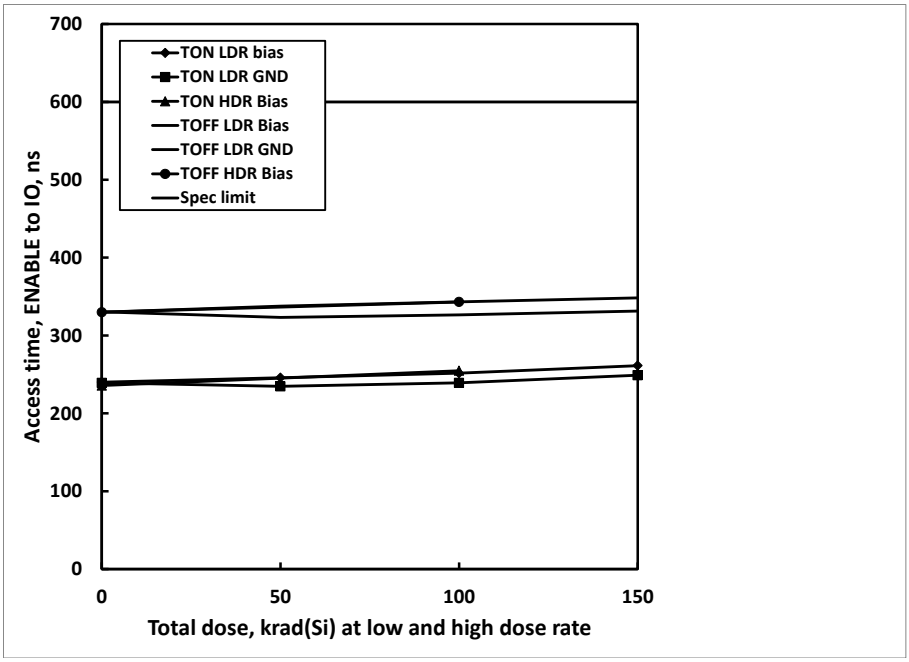

Figure 17: HS9-508BEH enable to switch access time as a function of total dose irradiation at low dose rate (biased and unbiased) and at high dose rate (biased only). The low dose rate was 0.01rad(Si)/s and the high dose rate was 60rad(Si)/s. Sample size for each low dose rate cell was 12, while the high dose rate sample size was 76. The SMD pre-irradiation limit is 600ns maximum.

6: Conclusion

This document reports the results of low and high dose rate total dose tests of the HS9-508BEH 8-channel analog multiplexer, with the high dose rate data derived from RLAT tests. Parts were tested at low dose rate under biased and unbiased conditions and at high dose rate under biased conditions to a maximum total dose of 150krad(Si) and 100krad(Si), respectively.

ATE characterization testing at downpoints showed excellent parametric stability and no rejects to the SMD Group A pre- or post-irradiation limits. Variables data for selected parameters is presented in Figs. 1 through 17. The samples showed no bias sensitivity or dose rate sensitivity.

7: Appendices

7.1: Reported parameters.

Figure	Parameter	Limit, low	Limit, high	Units	Notes
1	Positive supply current	-	2.0	mA	
1	Positive standby supply current	-	2.0	mA	
2	Negative supply current	-	-1.0	mA	
2	Negative standby supply current	-	-1.0	mA	
3	Positive analog signal range	-	15.0	V	
4	Negative analog signal range	-	-15.0	V	
5	Positive ON resistance	-	1800	ohms	

6	Negative ON resistance	-	1800	ohms	
7	Positive OFF source leakage	-10.0	+10.0	nA	
8	Negative OFF source leakage	-10.0	+10.0	nA	
9	Positive OFF drain leakage	-10.0	+10.0	nA	
10	Negative OFF drain leakage	-10.0	+10.0	nA	
11	Positive ON drain leakage	-10.0	+10.0	nA	
12	Negative ON drain leakage	-10.0	+10.0	nA	
13	Input HIGH leakage current	-1.0	+1.0	µA	Enable and address pins
14	Input LOW leakage current	-1.0	+1.0	µA	Enable and address pins
15	Address to switch access time	-	600.0	ns	
16	Break before make delay	-	25.0	ns	
17	Enable to switch access time	-	600.0	ns	

Note 1: Limits are taken from Standard Microcircuit Drawing (SMD) 5962-96742.

8: Document revision history

Revision	Date	Pages	Comments
0	1 August 2012	All	Original issue